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# INDEPENDENT RESEARCH AND INDEPENDENT EXPLORATORY DEVELOPMENT: ANNUAL REPORT

Naval Undersea Center
San Diego, California

July 1974

NAVAL UNDERSEA CENTER, SAN DIEGO, CA. 92132

AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

**ROBERT H. GAUTIER, CAPT, USN**
Commander

**D. J. WILCOX**
Technical Director, Acting

## ADMINISTRATIVE INFORMATION

This report is submitted in response to NAVMATINST 3920.3B of 12 June 1972. It consists of descriptions in layman's terms of four selected Independent Research and Independent Exploratory Development projects. (Two additional projects are included in the classified version of this report, NUC TP 423.) These descriptions are followed by a list of all projects active or terminated since the last annual report and of publications and patents resulting from them.

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This report summarizes the Independent Research and Independent Exploratory Development program at the Naval Undersea Center for the fiscal year 1974. The program consists of a variety of projects that are considered basic to the development of undersea surveillance, ocean engineering, and advanced weapons systems. The four projects featured in this report are among the

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20. Abstract (Continued)

most promising in these areas. (Two additional projects are included in the classified version of this report, NUC TP 423.)

The projects featured in this report are:

MINOX Program – the relationship between oceanic predictive correlates and sonic reverberation.

Acoustic Scattering from Fish Schools and the Deep Scattering Layer – the effects of biological aggregations on acoustic systems.

High-Speed Fourier Transforms – advances in signal processing techniques to improve the operation of modern communication systems.

Bioacoustic Capability of Marine Mammals – the intensive study of dolphins' behavior to determine if such knowledge can improve the operation of sonar systems.

# Contents

# Introduction

This report summarizes the Independent Research and Independent Exploratory Development program at the Naval Undersea Center for fiscal year 1974. The program consists of a variety of projects that are considered basic to the development of undersea surveillance, ocean engineering, and advanced weapons systems. The projects featured in this report are among the most promising in these areas.

This is the first year that the Center has issued a classified version of this annual report (NUC TP 423). The decision was made so that it would be possible to explain more completely the military significance of the selected projects. Also different from previous reports is the placement of the introductory remarks for each article immediately preceding the article, rather than in the introductory section. It is hoped that such an arrangement will display each project's independent significance.

The articles in this report represent a variety of disciplines. They range from the field of signal processing to marine mammal research. As a whole they represent not only novel solutions to defined Navy needs, but also the development of the scientific and technical expertise needed by the Navy to meet future challenges.

This year's projects include:

MINOX Program—the relationship between oceanic predictive correlates and sonic reverberation.

Acoustic Scattering from Fish Schools and the Deep Scattering Layer—the effects of biological aggregations on acoustic systems.

High-Speed Fourier Transforms—advances in signal processing techniques to improve the operation of modern communication systems.

Bioacoustic Capability of Marine Mammals—the intensive study of dolphins' behavior to determine if such knowledge can improve the operation of sonar systems.

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# Selected Independent Research Projects

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# MINOX program: oceanic predictive correlates of sonic reverberation

*This article and the following one address the interactions between the biological content of the ocean and the performance of acoustic systems. The false target problem of the acoustic homing torpedo operating at a relatively high frequency, the large number of false targets identified by moderate frequency sonars, and the acoustic emissions received by surveillance systems in the very low frequency range are believed to be at least partially caused by biological entities. Although the importance of such interactions has been recognized for several years, investigation of them has been minor. The two featured projects represent the start of an intensive effort in this general area. The MINOX program is concerned with the biological content of the ocean, and the volume reverberation program deals with biological effects at sonar and torpedo-homing frequencies. It is believed that these programs could result in an improved target discrimination capability for acoustic systems used by the Navy.*

Documents that provide reliable acoustic information in the marine environment are required for sonar models, such as the Navy Interim Surface Ship Sonar Prediction Model (NISSM). Of particular importance are major portions of the Pacific and Indian Oceans and adjacent seas. Because existing data are inadequate in vertical, temporal, and geographical dimensions, the Naval Undersea Center his instituted the Minimum Oxygen (MINOX) Program, the main objective of which is to devise bioacoustic models of oceanic regions based on physical and chemical parameters. It is planned to use these models to predict acoustic reverberation, caused by biological target populations, across a broad spectrum of frequencies, for example, from 1 to 60 kilohertz.

Since it is not possible to survey completely the world's oceans in all areas, depths, and seasons of interest, the approach in this program is to identify, where possible, the environmental aspects of acoustic reverberation that can be obtained by survey ships on routine missions and then rapidly analyzed while underway. Such parameters, either singly or in combination, control the occurrence and behavior of biological targets. Occasionally, these physical and chemical features prove to be the fundamental parameters of a recognized water mass.

The approach was to select an open ocean area where the major water masses are considered relatively stable physically (low current velocities and moderate convective processes) and the biological community is less complex than in the more productive inshore areas. The area selected, a tropical section of the northeastern Pacific Ocean, was north of the equator and measured more than 2.2 x $10^6$ square miles (figure 1). It had a dominant environmental feature of vanishing, low dissolved oxygen, that is, generally less than 0.05 milliliter of oxygen per liter of seawater.

The hypothesis was that the ultralow dissolved oxygen exerted a dominant and predictable effect on the occurrence and behavior of biological targets, whether aggregated into components of the deep scattering layer or as individual false targets (large near-surface fish or schools). Nearly simultaneous measurements of acoustic reverberation parameters with biological discrete depth samples were taken, and hydrographic casts for water samples were made to provide chemical, nutrient, and temperature data. This multidisciplinary approach was performed from one oceanographic vessel on three different cruises in July 1970, March 1972, and October 1973 (figure 2). The stations were occupied for 24 to 48 hours at a time.

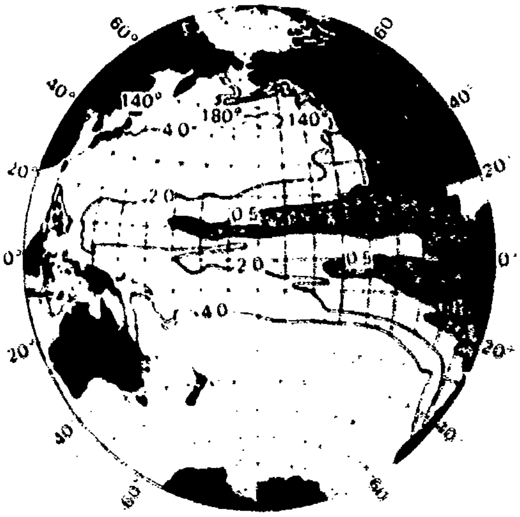


Figure 1. The area of the Pacific Ocean (darkest shading) where dissolved oxygen at some point in the water column is equal to or less than 0.5 milliliter of oxygen per liter of seawater.

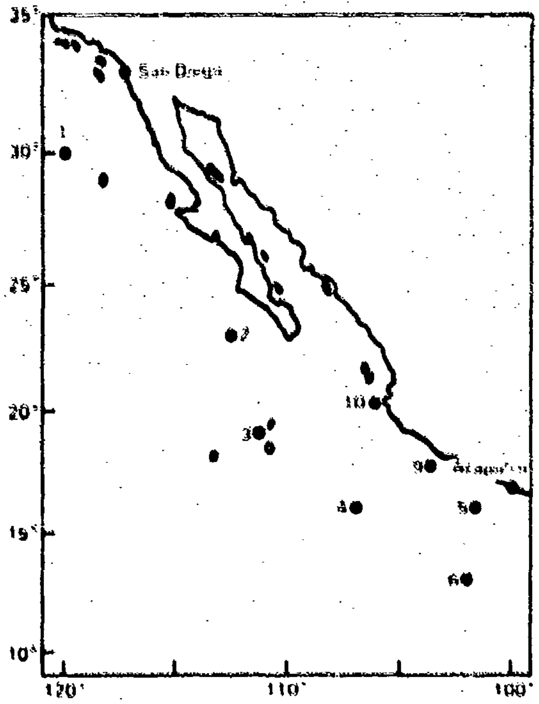


Figure 2. Stations occupied during the MINOS cruises. Station 1, north of the low oxygen area, serves as a point of reference and represents an area where dissolved oxygen is probably not a limiting feature of the environment. (Stations 7 and 8 were not occupied.)

Data obtained on the cruises were used to (1) measure the area's seasonal fluctuations in physical, chemical, biological, and acoustic parameters and (2) determine if the physical and chemical parameters, controlling the occurrence and behavior of biological targets and populations, can be identified and the interrelationships quantified into a useful format. The results provided strong evidence that the behavior of the components of the deep scattering layer and the occurrence of particular species of target fish with gas-filled swimbladders are governed by the presence of the low-oxygen water. Other conclusions include the following.

1. The biological activity of the area is highly developed.

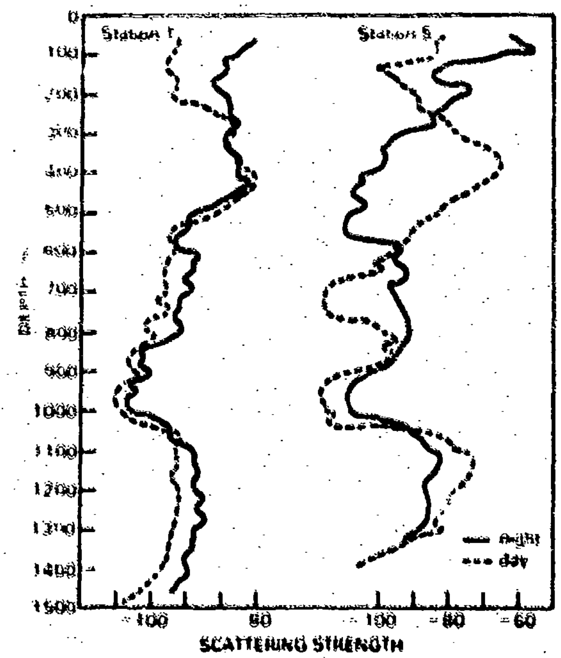


Figure 3. Acoustic profiles comparing day and night reverberation (expressed as scattering strength). Station 5 is in the low oxygen region, and station 1 is in the relatively oxygen-rich California Current area.
(Station 1: night measurements at 12 kHz on 10 July 1970, 2100 hours, with a column strength of −59; day measurements at 12 kHz on 11 July 1970, 1115 hours, with a column strength of −49.7. Station 5: night measurements at 12 kHz on 18 July 1970, 0000 hours, with a column strength of −41.2; day measurements at 12 kHz on 18 July 1970, 1130 hours, with a column strength of −45.1.)

2. The organisms comprising the deep scattering layer migrate to the surface at night, leaving a large acoustic window. The window, vertically ranging from 100 or 200 to 900 or 1,000 meters, has little or no volume reverberation above −100 to −110 decibels (volume scattering strength) across a spectrum of at least 1 to 12 kilohertz (figure 3).

3. At least two species of target fish from the deep scattering layer are characteristic of this region, thus permitting mapping on the basis of historical zoogeography.

4. Measured levels of dissolved oxygen are substantially lower than the values reported in the scientific literature or generally available from archival sources (figure 4).

It seems highly probable that the low level of dissolved oxygen forces the entire fish community in the deep scattering layer to leave the area for some period of time each day (a unique situation). The exact mechanisms for this response are as yet unresolved, but it is believed that the acoustic region, as it relates to biology, can be predicted throughout this area on the basis of the dissolved oxygen profile, provided the analyses are sufficiently accurate.

It is believed that in other areas of the world's oceans the target fish are no less stringently controlled by their chemical and physical environment. The controlling factors will probably be different, possibly more complex, and perhaps operating through one or more intermediate steps of the food chain.

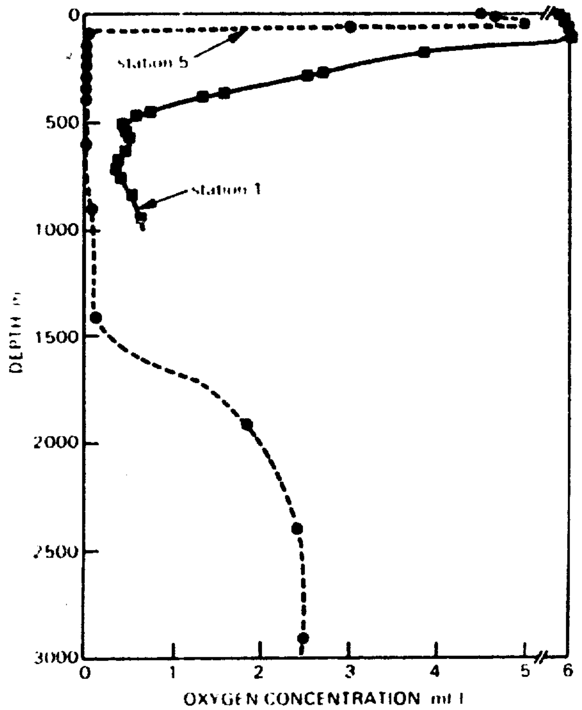


**Figure 4. Dissolved oxygen profiles representing stations 1 and 5. Note the very abrupt drop in dissolved oxygen at approximately 100 meters.**

# Acoustic scattering from fish schools and the deep scattering layer

As part of the Naval Undersea Center's coordinated investigation of biologically caused sound scattering, a program has been established to identify important interactions between oceanic biology and naval acoustic systems. Attention was concentrated this past year on (1) deep sea fish that scatter sound in the ocean and (2) fish that may acoustically resemble targets of military significance.

One part of the program was concerned with diffusive aggregations of plankton and fish that scatter sound transmitted in the sea and produce a background that may mask a wanted target. This scattering, or reverberation, of acoustic energy from an ensonified volume of water is called volume reverberation. It can be considered as an acoustic analog of fog, scattering light and reducing visual discrimination. Although this scattering exists throughout the ocean volume, it largely emanates from panoceanic, horizontally extensive layers of biota, known collectively as the deep scattering layer. Small (5 to 15 centimeters long) deep sea fish with gas-filled swimbladders that serve as buoyancy devices are the principal causes of this reverberation at sonar frequencies.

Research at the Center examined the relationship between the structure and distribution of deep sea fish and consequent volume reverberation. The data considered were column scattering strengths, that is, the scattering in a column of water of unit cross section, extending from the sea surface to 1,000 meters. The strength of the scattering was usually found to increase sharply with frequency between 1 and 6 kilohertz and then to become fairly constant to 20 kilohertz, the upper limit for such measurements. This pattern occurs because the scatterers' swimbladders are limited in size to a narrow range that determines the frequency region in which scattered returns are enhanced by swimbladder resonance and the scattering strength increases markedly. Above 5 or 6 kilohertz, the larger midwater fish are no longer resonant, and their contribution, combined with the increasing contributions from smaller forms, causes scattering to remain fairly constant to 20 kilohertz.

Calculations were made using acoustic theory applied to a fictitious assemblage of fish of plausible size and depth distribution; results strongly emulated conditions observed in nature. Net hauls and acoustic data were then compared. Fifteen night net hauls from a variety of depths yielded an average population of 2.2 fish per thousand cubic meters of water; the continuous curve in figure 1, calculated from these data shows the column scattering strength as a function of frequency. The individual points are acoustic measurements made at night on the same cruise. The broken curve occurred when a net sampling efficiency of 50 percent was assumed, that is, an actual population of 4.4 fish per thousand cubic meters. These results show fairly good agreement.

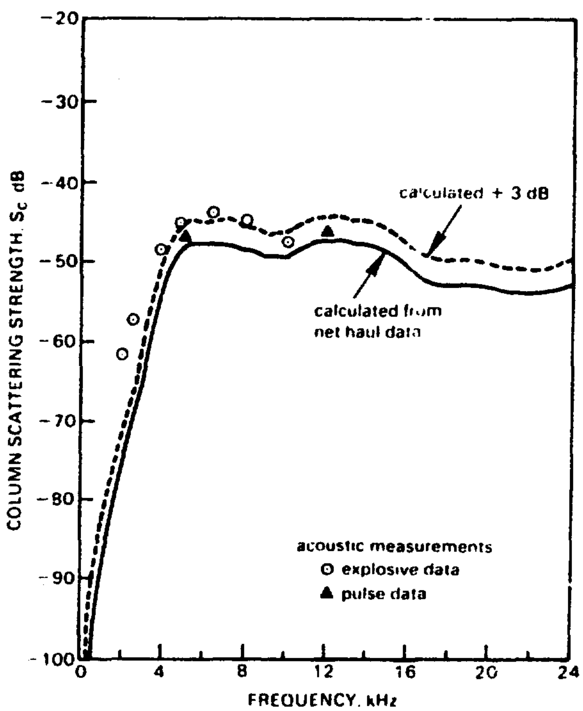


Figure 1. Comparison of calculated and net haul data.



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The exceptions, for data at 2 and 2.5 kilohertz, where catch data significantly underestimate the acoustic conditions, suggest that the larger fish successfully avoid capture.

Such results are encouraging. They indicate that reverberation conditions can be estimated for regions where acoustic measurements are lacking by using data on fish populations in the deep scattering layer.

The second part of the program investigated acoustic energy scattered from marine biota that can "blob up" and produce discrete echoes with target-like characteristics. Large biological entities, or, more particularly, fish schools, produce such returns. Sound scattering from fish schools has only recently received the emphasis previously given volume reverberation and the deep scattering layer. As a result, investigations of discrete echo phenomena from fish schools tend to be more basic than contemporary studies of the latter.

In the past year, data on and from fish schools were examined to define the acoustic conditions associated with schools and to identify the interactions between acoustic systems and fish schools that warrant additional investigation. The program addressed identification of Navy-relevant aspects of fish school information. Most information was obtained from fisheries-oriented research, which generally emphasizes the biological or behavioral aspects of schools rather than related data on acoustic properties. Although tools and techniques devised for fisheries applications were routinely used, the information was processed and analyzed in a framework more strictly acoustic than normal for a fisheries program.

Figure 2, illustrating information on fish schools, emphasizes aspects pertinent to Navy acoustic systems. Equipment developed for fisheries applications was used to gather data from

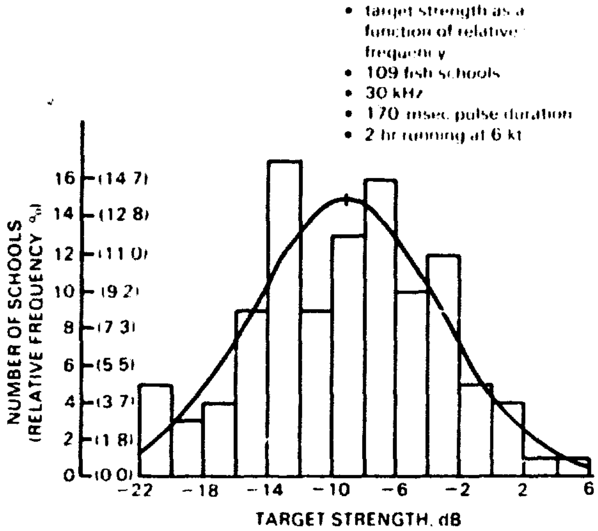



**Figure 2. Continuous-wave measurements, target strength distribution (fish schools)**

more than 100 schools that were encountered in a 2-hour period during a survey off California. A histogram representing the schools' target strengths, a measure of their ability to scatter sound incident upon them, is presented with a gaussian distribution fitted to the data. The schools were probably anchovy or jack mackerel, but their composition is less important than their target-like characteristics. Information such as number, target strength, and target strength distribution is directly applicable to the development and operation of naval acoustic systems. Properly integrated and interpreted, such information can increase the reliability and effectiveness of acoustic systems operating in the presence of biological aggregations.

# High-speed Fourier transform devices

*In underwater acoustic systems, large increases in performance are expected as a result of order-of-magnitude improvements in signal processing. In this project, which illustrates one such improvement, the chirp-Z transform, developed in connection with other applications, is applied to underwater acoustic signal processing. The result is an increase in capacity and speed for handling acoustic data, which should contribute to improved performance for sonar and surveillance systems.*

To achieve improved detection, classification, and localization of targets, as well as improved communication in the presence of noise and jamming, spectrum analysis, crossconvolution or linear filtering, and beamforming are required by sonar, radar, and communication systems.

Such signal processing operations can be performed via the discrete Fourier transform (DFT) as shown in figure 1 (parts A through D). It has recently become common practice to use the fast Fourier transform (FFT) algorithm to increase the speed of computing the DFT. (The FFT algorithm is a special computational technique which allows computation of discrete Fourier transforms via elimination of redundant arithmetic operations.) The chirp-Z transform (CZT) algorithm was originally designed to circumvent the FFT's restriction of being compatible with only special data block sizes. The CZT performs a DFT as a premultiplication by a discrete chirp, a convolution with a discrete chirp, or a postmultiplication by a discrete chirp (figure 2, part A). If the convolution needed in the CZT is performed with an FFT, then the CZT will be slower than an FFT of comparable length. However, if the convolution is performed with transversal filters, then the CZT is significantly faster than an FFT with the same computational cycle time. The relative times required to compute the DFT are shown in table 1.

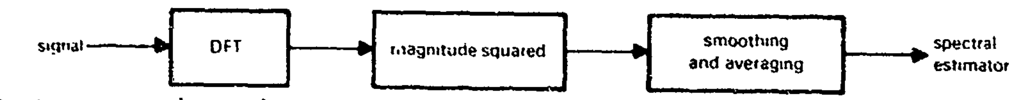
The Center has developed an implementation of the CZT using surface acoustic wave transversal filters. Not only is the CZT faster than an FFT with the same time per computational cycle, but the computational cycle time with these filters is shorter than with a digital computer.

The required complex multiplications and convolutions (figure 2, part A) have been implemented by sets of four of the corresponding real operations as shown in figure 2, part B. Two identical surface acoustic wave modules are used in the transform device. Each module has two cosine chirp filters and two sine chirp filters, all on a common quartz substrate (see figure 3). One module is used as an acoustic read-only memory to provide the premultiplier and postmultiplier reference functions, and the second module provides the required convolution with a complex chirp. Figure 4 shows the CZT device operating as a spectrum analyzer with a set of complex sinusoidal test signals.

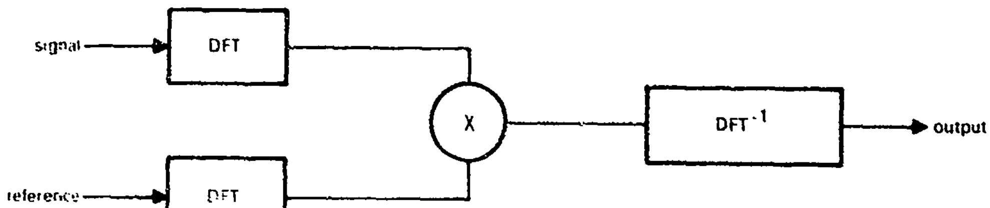
The surface acoustic wave technology needed for the CZT device was developed under the Center's Independent Research Program. Although the CZT algorithm was previously known, the technology for the surface acoustic wave devices provided the first means for its high-speed implementation via transversal filters. The SAW module and the CZT system (figure 2, part B) were

Table 1. Comparison of Discrete Fourier Transform Computation Times.

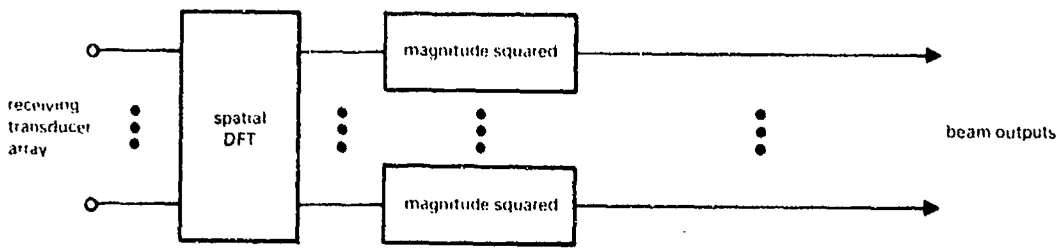
| Method | No. of Computation Cycles Required for a Block Size N |
|---|---|
| Direct summation | $N^2$ |
| FFT | $N \log_2 N$ |
| CZT using an FFT | $>2 N \log_2 N$ |
| CZT using transversal filters | $2 N$ |



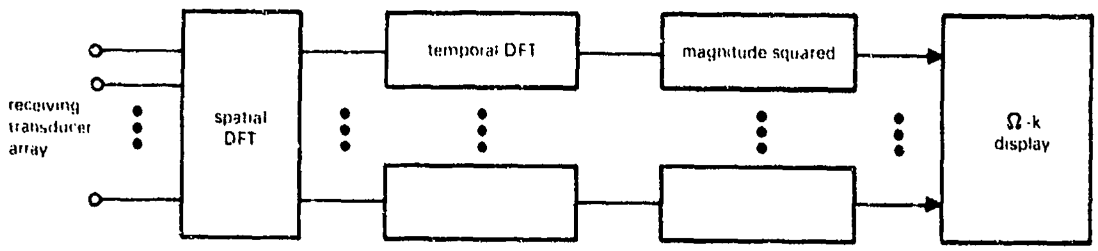

**Part A. Spectrum analysis via the DFT.**




**Part B. Crossconvolution or linear filtering via the DFT.**



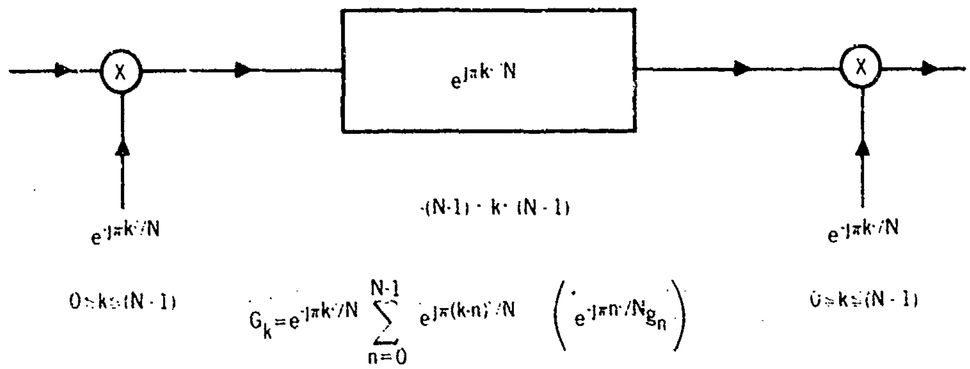

**Part C. Narrowband beamforming via the DFT.**



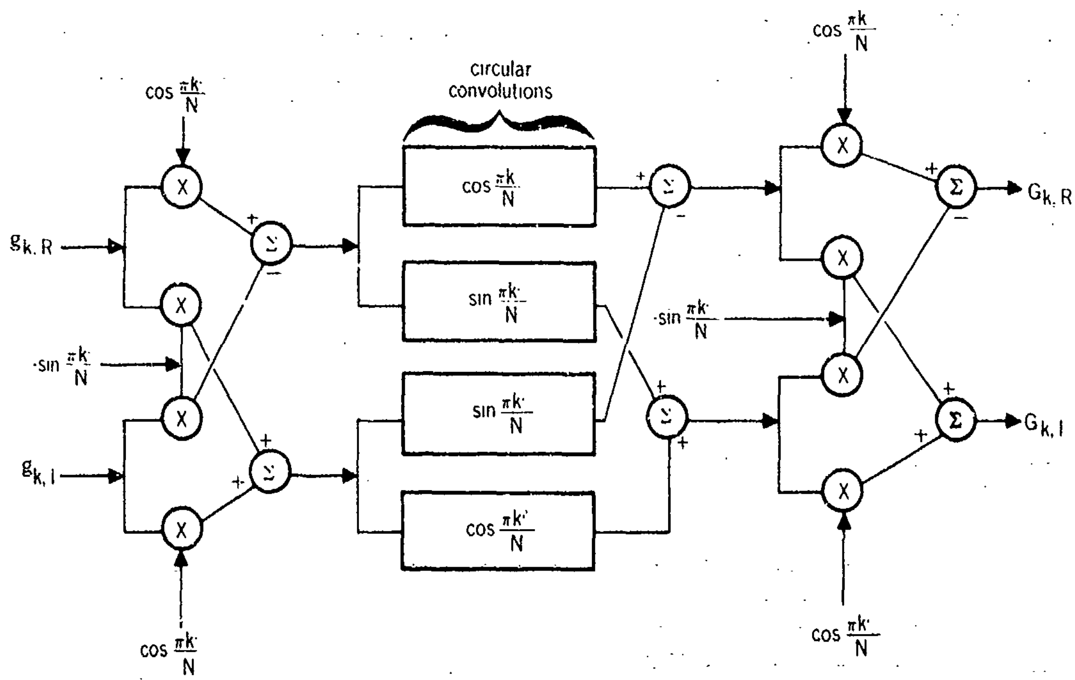

**Part D. Broadband beamforming via the DFT.**

$$G_k = \sum_{n=0}^{N-1} g_n \, e^{-j2\pi kn/N}$$

**Figure 1. Signal processing using the discrete Fourier transform.**




**Part A. Serial access implementation of the DFT.**




**Part B. DFT via CZT algorithm with parallel implementation of complex arithmetic.**

**Figure 2. Implementation.**

designed, built, and successfully tested at the Center.

The techniques for high-speed serial access implementation of linear transforms using transversal filters, extended to other technologies and types of transforms, are now being applied in other program areas.

A

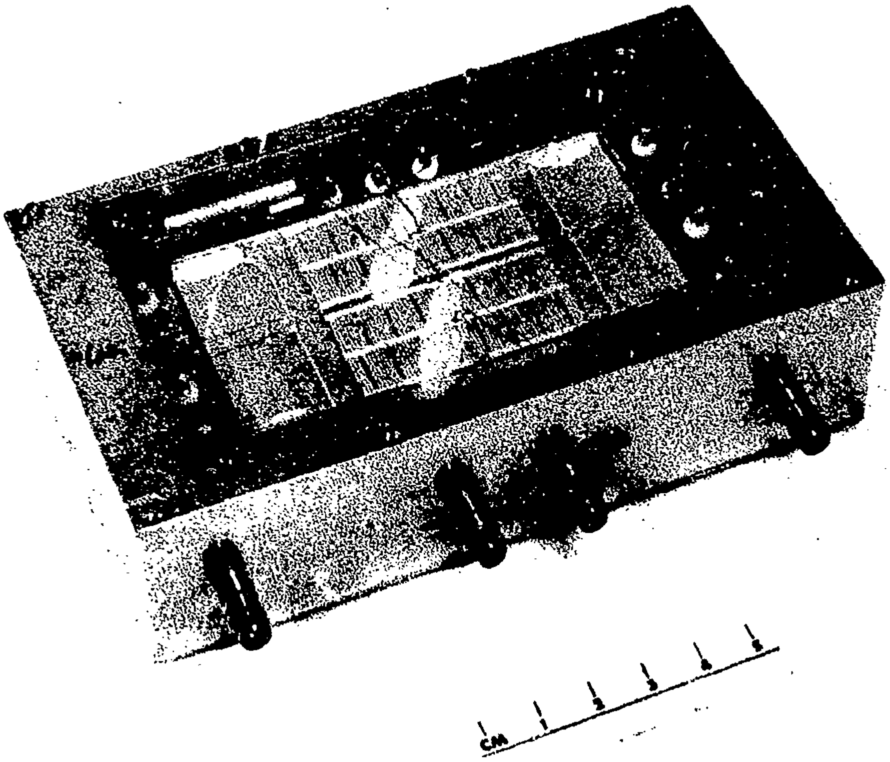
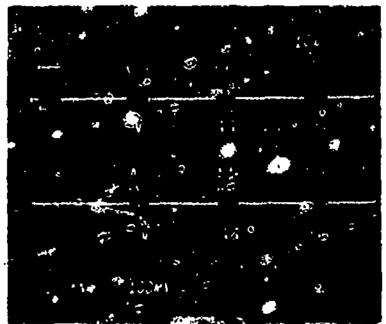


Figure 3. CZT trans:ersal filter.

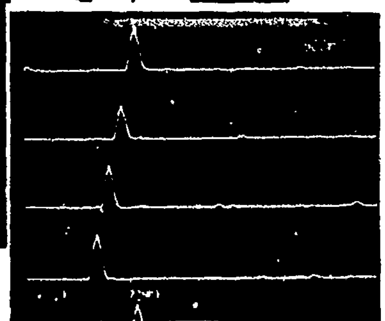


Part A. Spectrum analysis via the DFT.

B

C

Figure 4. Surface ccoustic wave CZT spectrum analysis.



D

Part B. Crossconvolution.

# Selected Independent Exploratory Development Projects

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# Bioacoustic capability of marine mammals

*Marine mammals have biological sonar systems which are essential to their underwater existence. We have learned how to train them to use this inherent acoustic capability to assist in underwater operations, and we are attempting to simulate some of their outstanding acoustic abilities in the interest of improving our physical systems. But, we do not yet have sufficient information or understanding of their basic acoustic capability to support a full range of applications. The research in this independent research project addresses the determination of their basic capabilities. As a result of it, the Navy will be in a better position to develop such applications.*

Research has shown that dolphins possess highly sophisticated echolocation or echoranging systems. Results of bisonar studies have led many to consider dolphins as representing the optimum sonar system under certain conditions: For a shallow water, high clutter, and high ambient noise environment, there probably does not exist any sonar system that can outperform a dolphin in detecting and characterizing small sonar targets.

Echolocation detection threshold experiments, being performed in the open water of Kaneohe Bay, Hawaii, are providing insights on the actual detection capability of the Atlantic bottlenose dolphin. The adaptive capability of the mammals in shaping their echolocation signals so that their performance is optimized in any given environment is the bisonar area currently under investigation. An experiment using two dolphins housed in a floating pen and a catenary suspension system to position sonar targets at various ranges away from the animals is illustrated in figure 1. Data on the performance of the animals in detecting via echolocation the presence or absence of small spherical targets as a function of range were collected. The target was presented 50 percent of the time at a depth of 4 feet. The detection task was not simple since there was (1) a background reef which contained much clutter (approximately the same size as the target), (2) a small hump along the bottom of the bisonar range which highlighted any sonar PPI display, and (3) a high ambient noise level caused by snapping shrimp. However, even in this high clutter environment, the dolphins were able to detect the presence or absence of the small 1-inch sphere incredibly well at fairly long ranges.

The primary factors which contribute to differences between sonars in detecting, resolving, and discriminating targets are the signals, flexibility in controlling the signal characteristics for different environments and conditions, and type of signal processing. Echolocation signal measurements made in conjunction with the detection threshold study have indicated the tremendous adaptability of the dolphin sonar system. A typical echolocation system and its frequency spectrum are displayed in figure 3. The peak-to-peak sound pressure level in decibels referenced to 1 microbar at 1 yard is listed with the waveform. Two important features are the high sound pressure level and the high frequency aspect of the signal. The average value of the several thousand echolocation clicks measured indicated a peak-to-peak sound pressure level of approximately 121 decibels referenced to 1 microbar at a distance 1 yard in front of the animals. This value represents a source level at least 30 decibels higher than previously reported for measurements performed in tanks, emphasizing the considerable dynamic range of the animals. The peak frequencies also deviated substantially from past measurements. Previous values ranged from 30 to 60 kilohertz, whereas present values indicate peak frequencies of approximately 120 kilohertz. Again, this shows the tremendous flexibility of dolphins in controlling the makeup of their sonar signals to best suit the conditions and environment to which they are exposed.

Also investigated were (1) the vertical and horizontal beampatterns, (2) the acoustic near- and

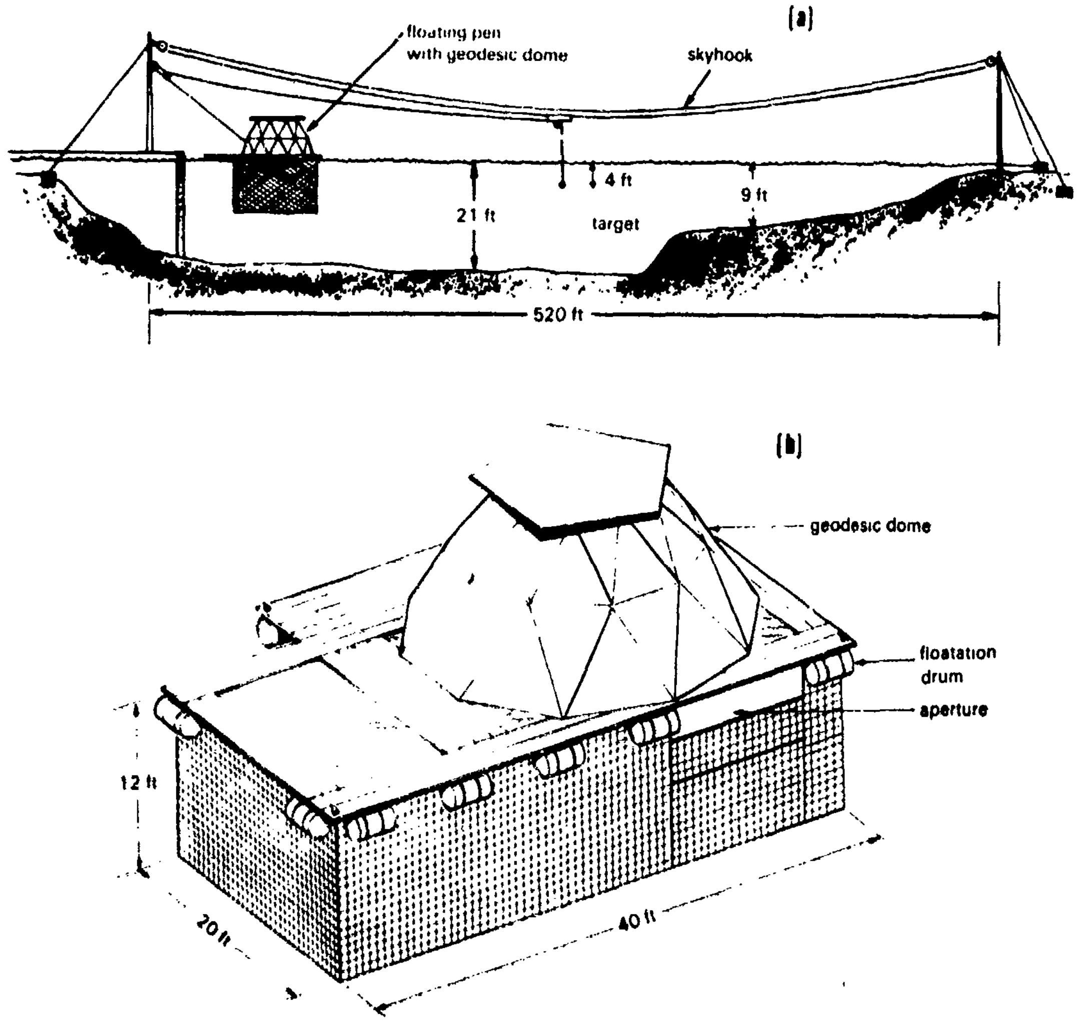


Figure 1. Cross sectional view of the biosonar range (top) and floating pen (bottom).

far-field relationships, (3) the propagation characteristics of the echolocation signals, and (4) the relationship of the signals measured in the far field. A nose-cup stationing device (figure 4) was used to position the rostrum of the animal during echolocation. Multihydrophone arrays spaced either vertically or horizontally simultaneously measured the echolocation signals at different locations.

The composite vertical beam of the animal is shown in figure 5. The major axis of the beam extends at an angle of 20 degrees above the horizon, and the 3-decibel beamwidth is approximately 8 degrees. The beampattern for individual echolocation trials is similar to the composite in figure 5. The composite horizontal beampattern (figure 6) has a 3-decibel beamwidth of approximately 8.5

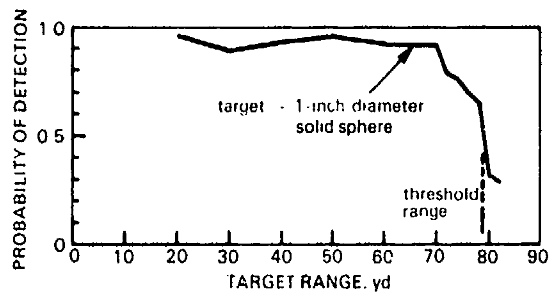


Figure 2. Results of animals' performance in an echolocation detection experiment using a 1-inch-diameter sphere as the target.

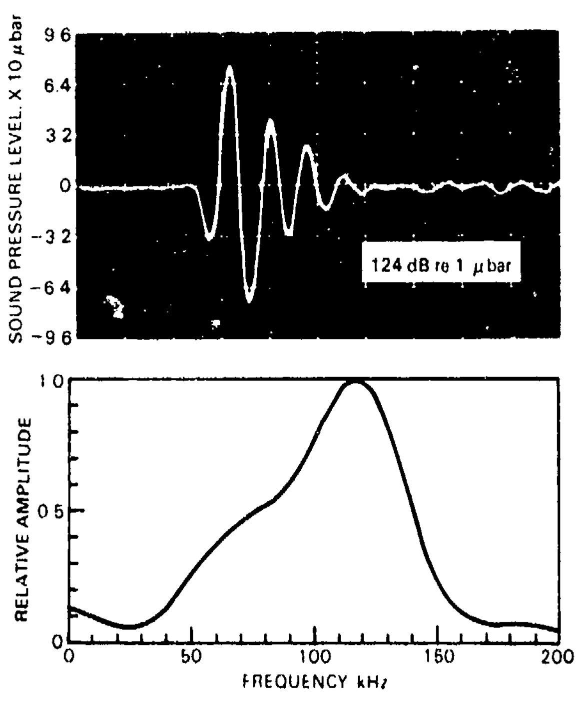


Figure 3. Typical echolocation signal waveform and its frequency spectrum.

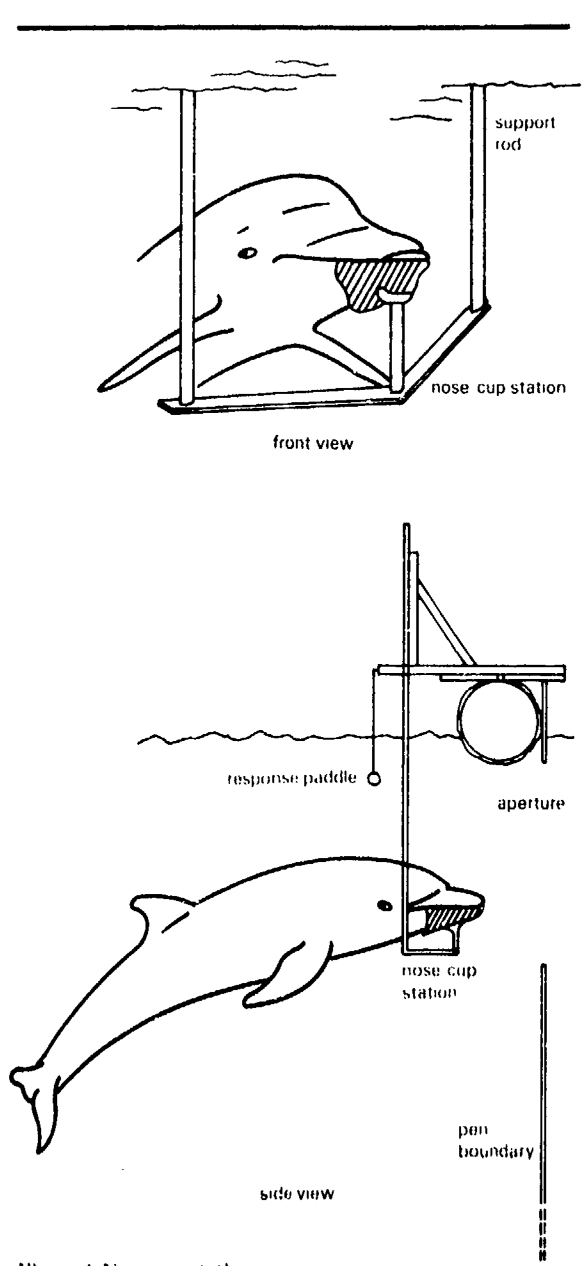


Figure 4. Nose-cup station.

degrees. Using the beampatterns in the vertical and horizontal planes, the directivity index was calculated to be 25 decibels. The acoustic power of an echolocation click can be calculated by using the rms sound pressure level of the click and the directivity index. The average click represents approximately 10 watts, although values as high as 20 watts are fairly common.

The sound pressure level as a function of distance, radially away from the animal along its longitudinal axis, is shown in figure 7. The sound pressure has been referenced to the corresponding sound pressure measured 1.09 yards (1 meter) from the tip of the animal's rostrum or approximately 1.36 yards (1.25 meters) from the acoustic center. Defining the far field as the region in space in

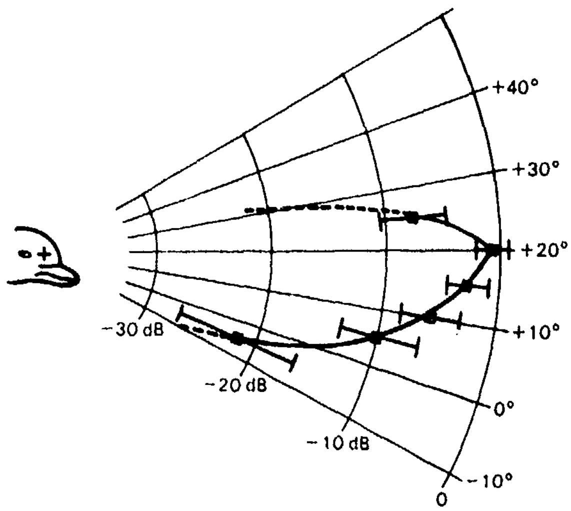


Figure 5. Composite vertical beampattern of the transmitted signals.

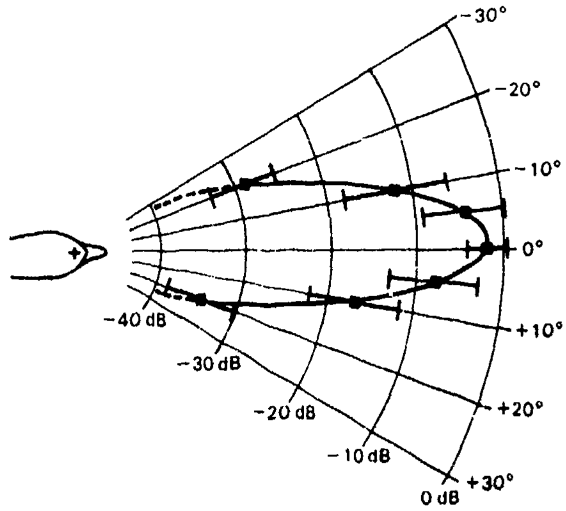


Figure 6. Composite horizontal beampattern of the transmitted signals.

which the sound pressure decays in a 1/R fashion, the transition region from the near field is approximately 0.71 to 0.77 yard (0.65 to 0.7 meter) from the acoustic center.

Additional information, such as the effects of different target parameters (size, shape, composition, and range) on the animal's choice of echolocation signals, would enhance the understanding of the sonar target classification problem and eventually lead to the development of more sophisticated sonar systems.

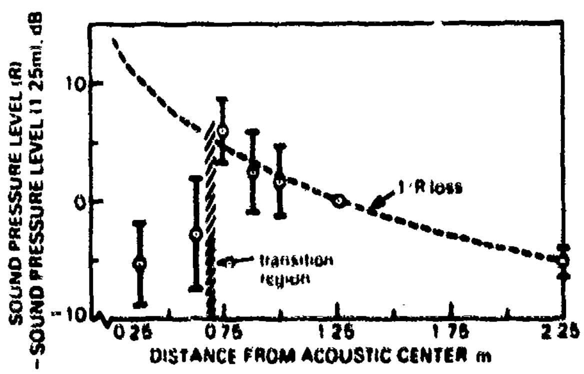


Figure 7. Relative sound pressure levels as a function of distance from the acoustic source within the animal.

# Projects Active or Terminated Since Last Annual Report

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# Independent research projects*

## *active*

| PROJECT TITLE AND PRINCIPAL INVESTIGATOR | TASK AREA | FY 1974 FUNDING | AGENCY ACCESSION NO. |
| --- | --- | --- | --- |
| ECHO ELONGATION<br>*F. Marshall, Code 3525*<br>*714-225-2309* | ZR 011-08-01 | $ 20,000 | DN 488 506 |
| NUMERICAL REPRESENTATION OF SOUND VELOCITY FIELD<br>*J. Brown, Code 4534*<br>*714-225-2315* | ZR 011-08-01 | 5,000 | DN 488 642 |
| VOLUME REVERBERATION<br>*W. Friedl, Code 503*<br>*714-225-7828* | ZR 011-08-01 | 102,500 | DN 018 719 |
| IMPROVEMENT OF CURV DETECTION CAPABILITY<br>*J.W. Young, Code 601*<br>*714-225-6301* | ZR 011-08-01 | 200,000 | DN 234 787 |
| INDUCED DOPPLER SONAR<br>*T J Keil, Code 6512*<br>*714-225-7762* | ZR 011-08-01 | 20,000 | DN 488 677 |
| MAGNETO-OPTICAL SIGNAL PROCESSOR<br>*J V Thorn, Code 6513*<br>*714-225-2271* | ZR 011-12-01 | 25,000 | DN 488 664 |
| FLOW NOISE VIBRATION THEORY<br>*R W White, Code 4542*<br>*714-225-2549* | ZR 012-06-01 | 20,000 | DN 488 525 |

*Funding for fiscal year 1975 was not available at time of publication

| PROJECT TITLE AND PRINCIPAL INVESTIGATOR | TASK AREA | FY 1974 FUNDING | AGENCY ACCESSION NO. |
|---|---|---|---|
| RATE OF SOLUTION OF HYDROGEN GAS BUBBLES IN SEAWATER<br>*S. Yamamoto, Code 504*<br>*714-225-7124* | ZR 013-01-01 | 40,000 | DN 488 651 |
| CHEMISTRY AT THE SEA SEDIMENT INTERFACE<br>*S. Yamamoto, Code 504*<br>*714-225-6340* | ZR 013-01-01 | 45,000 | DN 118 746 |
| TENSOR ANALYSIS, SAMPLED DATA<br>*C. Johansen, Code 252*<br>*714-225-2407* | ZR 014-08-01 | 20,000 | DN 488 680 |
| NEW CONCEPTS' DEVELOPMENT<br>*R. Means, Code 608*<br>*714-225-6872* | ZR 021-01-01 | 76,900 | DN 234 678 |
| TENSILE STRENGTH OF WATER<br>*J. Hoyt, Code 2501*<br>*714-225-2415* | ZR 023-01-01 | 22,000 | DN 488 520 |
| BIOCHEMICAL RESEARCH ON MARINE FOULING<br>*D. Wilson, Code 0102*<br>*714-225-6491* | ZR 031-02-01 | 50,000 | DN 018 903 |
| EFFECT OF BENTHIC MARINE ANIMALS ON ORDNANCE<br>*B. Salazar, Code 2542*<br>*714-225-7459* | ZR 031-02-01 | 25,000 | DN 949 319 |
| RADIOTELEMETRY OF CLINICAL DATA FROM MARINE MAMMALS<br>*R. Seeley, Code 402*<br>*714-225-7838* | ZR 031-02-01 | 29,700 | DN 234 621 |

| PROJECT TITLE AND PRINCIPAL INVESTIGATOR | TASK AREA | FY 1974 FUNDING | AGENCY ACCESSION NO. |
|---|---|---|---|
| **TRACE ELEMENT DISTRIBUTION IN THE SEA** *H. Weiss, Code 504 714-225-6340* | ZR 031-02-01 | 55,500 | DN 118 747 |
| **MINOX PROGRAM** *G. Pickwell, Code 504 714-225-7829* | ZR 031-02-01 | 30,000 | DN 488 538 |
| **DEEP OCEAN DYNAMICS** *J. Cairns, Code 503 714-225-7951* | ZR 031-03-01 | 43,000 | DN 488 539 |
| **DETERMINISTIC INVESTIGATION OF UNDERWATER SOUND FLUCTUATION** *O. Lee, Code 503 714-225-6218* | ZR 031-03-01 | 47,000 | DN 488 540 |
| **DIRECTIONAL HEARING OF SEA LIONS** *R. Pepper, Code 4032 808-254-4409* | ZR 041-01-01 | 5,000 | DN 488 656 |
| **BIOLUMINESCENT STUDY** *J. Hoyt, Code 2501 714-225-2415* | ZR 041-26-01 | 1,000 | Unavailable |
| **EVALUATION OF BIOASSAY TECHNIQUES** *B. Salazar, Code 2541 714-225-7459* | ZR 041-26-01 | 23,000 | DN 488 521 |
| **ELECTROPHYSIOLOGY OF DOLPHIN CORTEX** *S. Ridgway, Code 402 714-225-7838* | ZR 041-26-01 | 30,000 | DN 234 876 |
| **DETERMINANTS OF DOLPHIN MOTIVATION** *R. Pepper, Code 4032 808-254-4410* | ZR 041-26-01 | 48,800 | DN 488 532 |

| PROJECT TITLE AND PRINCIPAL INVESTIGATOR | TASK AREA | FY 1974 FUNDING | AGENCY ACCESSION NO. |
| --- | --- | --- | --- |
| **BIOLOGICAL FALSE SONAR TARGETS**<br>*J. Fish, Code 405*<br>*714-225-2243* | ZR 041-26-01 | 17,000 | DN 488 511 |
| **BIOACOUSTIC CAPABILITY OF MARINE MAMMALS**<br>*W. Au, Code 4031*<br>*808-254-4179* | ZR 041-26-01 | 45,000 | DN 488 534 |
| **VENOMOUS AND DANGEROUS ANIMALS AFFECTING NAVAL OPERATIONS**<br>*G. Pickwell, Code 504*<br>*714-225-7829* | ZR 041-26-01 | 39,700 | DN 234 706 |
| **NORMAL MODE ACOUSTIC COMMUNICATION STUDIES**<br>*D. Marsh, Code 6023*<br>*714-225-7851* | ZR 011-08-01 | 5,500 | DN 488 712 |
| **ACOUSTIC SIGNATURE ANALYSIS**<br>*E. Floyd, Code 503*<br>*714-225-6306* | ZR 011-08-01 | 1,700 | Unavailable |
| **LOW-FREQUENCY SOURCE ANALYSIS**<br>*R. Smith, Code 601*<br>*714-225-6301* | ZR 011-08-01 | 13,000 | Unavailable |
| **MULTISTATION DATA VARIANCE STUDY**<br>*R. Trueblood, Code 606*<br>*714-225-7131* | ZR 021-05-01 | 4,000 | DN 488 643 |
| **CONCRETE SUBMERSIBLES STUDY**<br>*J. Stachiw, Code 6505*<br>*714-225-7811* | ZR 031-01-01 | 15,000 | Unavailable |

## Independent research projects

*terminated*

| PROJECT TITLE AND PRINCIPAL INVESTIGATOR | TASK AREA | FY 1974 FUNDING | AGENCY ACCESSION NO. | REASON FOR TERMINATION |
|---|---|---|---|---|
| UNDERWATER VISIBILITY MODEL<br>*A. Gordon, Code 6511*<br>*714-225-6686* | ZR 041-05-01 | $ 2,000 | DN 234 617 | Completed |
| SONAR SIGNAL PROCESSOR IMPLEMENTATION STUDY<br>*L. Mulcahy, Code 603*<br>*714-225-7645* | ZR 021-05-01 | 7,000 | DN 234 809 | Completed |
| MODULAR OUTFITTING, SWATH SHIPS<br>*P. Warnshuis, Code 608*<br>*714-225-6497* | ZR 023-03-01 | 5,200 | DN 334 646 | Completed |
| ACOUSTICS RESEARCH ON TUNA PORPOISE PROGRAM<br>*J. Fish, Code 405*<br>*714-225-22[illegible]3* | ZR 041-26-01 | 11,000 | DN 488 551 | Completed |

# Independent exploratory development projects*

*active*

| PROJECT TITLE AND PRINCIPAL INVESTIGATOR | TASK AREA | FY 1974 FUNDING | AGENCY ACCESSION NO. |
|---|---|---|---|
| DUAL LENS SONAR<br>*M. Morrison, Code 023*<br>*714-225-7112* | ZF 61-112-001 | $ 26,500 | DN 488 660 |
| ADAPTIVE LINE ENHANCING<br>*D. Chabries, Code 2522*<br>*714-225-2406* | ZF 61-112-001 | 40,000 | DN 488 505 |
| TEST AND EVALUATION OF EXPENDABLE PROBE<br>*E. Tunstall, Code 502*<br>*714-225-2316* | ZF 61-112-001 | 20,000 | DN 488 698 |
| SIGNAL PROCESSING IMAGER USING CHARGE TRANSFER ARRAYS<br>*H. Whitehouse, Code 6003*<br>*714-225-6315* | ZF 61-112-001 | 50,000 | DN 488 708 |
| AUTOMATIC DETECTION OF COMMUNICATION SIGNALS<br>*D. Gingras, Code 603*<br>*714-225-2391* | ZF 61-112-001 | 38,000 | DN 488 574 |
| VLF BROADBAND FLAT RESPONSE TRANSDUCER<br>*F. Abbott, Code 601*<br>*714-225-6301* | ZF 61-112-001 | 35,100 | DN 334 626 |
| TARGET IDENTIFICATION BY HARMONIC FREQUENCY DETECTION (HARD)<br>*J. Huang, Code 603*<br>*714-225-2156* | ZF 61-112-001 | 54,800 | DN 488 509 |

*Funding for fiscal year 1975 was not available at time of publication.

| PROJECT TITLE AND PRINCIPAL INVESTIGATOR | TASK AREA | FY 1974 FUNDING | AGENCY ACCESSION NO. |
|---|---|---|---|
| SURFACE EFFECTS' DETECTION<br>*C. Ramstedt, Code 608*<br>*714-225-6498* | ZF 61-112-001 | 48,000 | DN 488 513 |
| REAL-TIME OPTICAL MAPPING SYSTEM (ROMS)<br>*P. Heckman, Code 6511*<br>*714-225-6686* | ZF 61-112-001 | 54,000 | DN 488 648 |
| OPTICAL DATA MULTIPLEXING FOR TOWED ACOUSTIC ARRAYS<br>*J. Redfern, Code 6021*<br>*714-225-6613* | ZF 61-212-001 | 8,000 | DN 118 800 |
| RADAR CROSS SECTION OF SWATH SHIPS<br>*P. Warnshuis, Code 608*<br>*714-225-6497* | ZF 61-412-001 | 60,000 | DN 488 619 |
| SUPERCONDUCTING GRADIOMETER<br>*R. Means, Code 608*<br>*714-225-6872* | ZF 61-412-001 | 40,000 | DN 488 700 |
| NONNUCLEAR SUBMARINE TANKER (SSO)<br>*R. Bass, Code 608*<br>*714-225-6653* | ZF 61-412-001 | 9,000 | DN 488 556 |
| SMALL UNMANNED VEHICLES<br>*R. Fugitt, Code 6512*<br>*714-225-7630* | ZF 61-412-001 | 75,000 | DN 234 795 |
| RPV FOR NONHUMAN GUIDANCE SYSTEM<br>*J. Pond, Code 655*<br>*714-225-7217* | ZF 61-412-001 | 75,000 | DN 488 550 |

| PROJECT TITLE AND PRINCIPAL INVESTIGATOR | TASK AREA | FY 1974 FUNDING | AGENCY ACCESSION NO. |
|---|---|---|---|
| SURVEILLANCE SUPPORT<br>*S. Sullivan, Code 023*<br>*714-225-7113* | ZF 61-512-001 | 30,000 | Unavailable |
| STABLE SEMISUBMERGED PLATFORM (SSP)<br>*M. Baldwin, Code 022*<br>*714-225-7957* | ZF 61-512-001 | 50,000 | DN 488 527 |
| SCATTERING FROM ACOUSTIC COATINGS<br>*J. Young, Code 023*<br>*714-225-6301* | ZF 61-512-001 | 2,000 | Unavailable |
| SWATH AIR ASW MISSION, EQUIPMENT ANALYSIS<br>*J. Avery, Code 14*<br>*714-225-6755* | ZF 61-512-001 | 25,000 | DN 488 519 |
| PROCEDURES FOR EVALUATING HARDWARE AND TACTICS AT SEA<br>*C. Sturtevant, Code 141*<br>*714-225-7646* | ZF 61-512-001 | 1,000 | DN 234 673 |
| MARINE ENERGY FARM<br>*J. Steele, Code 4033*<br>*808-254-4477* | ZF 61-512-001 | 100,000 | DN 488 657 |
| ANIMAL GUIDANCE SYSTEM<br>*R. Soule, Code 403*<br>*808-254-4322* | ZF 61-512-001 | 81,500 | DN 488 533 |
| PACIFIC PILOT WHALE, EVALUATION OF ITS EFFECT ON HIGH-FREQUENCY SONAR AND ITS FEASIBILITY AS A MONITORING PLATFORM<br>*W. Evans, Code 402*<br>*714-225-7838* | ZF 61-512-001 | 48,000 | DN 234 826 |
| NEAR OPTIMAL SIGNAL PROCESSING<br>*G. Martins, Code 601*<br>*714-225-6304* | ZF 61-512-001 | 1,000 | Unavailable |

| PROJECT TITLE AND PRINCIPAL INVESTIGATOR | TASK AREA | FY 1974 FUNDING | AGENCY ACCESSION NO. |
|---|---|---|---|
| ARRAY PROCESSING<br>*H. Whitehouse, Code 6003*<br>*714-225-6315* | ZF 61-512-001 | 20,000 | Unavailable |
| NONLINEAR ACOUSTIC INTERACTION<br>*H. Whitehouse, Code 6003*<br>*714-225-6315* | ZF 61-512-001 | 25,000 | Unavailable |
| TESTING OF 3000-TON SEMISUBMERGED SHIP MODEL<br>*D. Higdon, Code 608*<br>*714-225-6496* | ZF 61-512-001 | 11,900 | DN 334 645 |
| VTOL LANDING POSITION SYSTEM (LAPSS), SHIP MOTION PREDICTION<br>*J. Beasley, Code 655*<br>*714-225-7217* | ZF 61-512-001 | 61,000 | DN 488 549 |
| AUTOMATIC MANIPULATOR POSITIONING SYSTEM<br>*C. Morrin, Code 6511*<br>*714-225-6862* | ZF 61-512-001 | 10,000 | DN 488 663 |
| WATER INFLATABLE ARRAYS<br>*J. Stachiw, Code 6505*<br>*714-225-7811* | ZF 61-512-001 | 49,100 | DN 234 788 |
| TOOLS FOR NAVAL INSHORE WARFARE<br>*R. Seple, Code 653*<br>*808-254-4338* | ZF 61-512-001 | 109,500 | DN 118 727 |
| MINISONAR PROPOSAL DESIGN<br>*H. Vollberg, Code 6531*<br>*808-254-4331* | ZF 61-112-001 | 10,000 | Unavailable |
| ECHO RANGING ON SS 365<br>*J. Reeves, Code 4543*<br>*714-225-7112* | ZF 61-512-001 | 5,000 | Unavailable |

# Independent exploratory development projects

## *terminated*

| PROJECT TITLE AND PRINCIPAL INVESTIGATOR | TASK AREA | FY 1974 FUNDING | AGENCY ACCESSION NO. | REASON FOR TERMINATION |
|---|---|---|---|---|
| EVALUATION OF TARGET CLASSIFICATION CONCEPT<br>*H. Volberg, Code 6531*<br>*808-254-4331* | ZF 61-112-001 | $ 60,000 | DN 488 537 | Completed |
| RADIO-CONTROLLED SONAR VEHICLE<br>*J. Clifton, Code 608*<br>*714-225-6495* | ZF 61-412-001 | 14,000 | DN 234 829 | Completed |
| CLOSED-CYCLE POWER POD<br>*A. Rathsam, Code 608*<br>*714-225-6871* | ZF 61-412-001 | 37,100 | DN 234 830 | Funds Discontinued |
| ACRYLIC PRESSURE HULL TECHNOLOGY<br>*J. Stachiw, Code 6505*<br>*714-225-7811* | ZF 61-412-001 | 40,000 | DN 234 611 | Completed |
| STUDY OF TARGET CLASSIFICATION USING NONLINEAR FEATURE SELECTION TECHNIQUES<br>*J. Roese, Code 6032*<br>*714-225-2391* | ZF 61-512-001 | 55,000 | DN 234 807 | Completed |
| VIDEO STORAGE AND RETRIEVAL (VISAR)<br>*D. Solarek, Code 6513*<br>*714-225-2270* | ZF 61-512-001 | 13,000 | DN 488 710 | Completed |
| DUAL HYDRODYNAMIC WINCH LIFT MECHANISM<br>*S. Moran, Code 6513*<br>*714-225-2271* | ZF 61-512-001 | 19,600 | DN 334 628 | Completed |
| PULL-DOWN RETRIEVER<br>*S. Moran, Code 6513*<br>*714-225-2271* | ZF 61-512-001 | 5,000 | DN 488 667 | Completed |

# Publications

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# Articles and reports

**Crozier, T. E., S. Yamamoto.** The Solubility of Hydrogen in Water, Seawater, and NaCl Solutions. *Journal of Chemical and Engineering Data,* Vol. 19. July 1974.

**Flanigan, W. F., Jr.** Nocturnal Behavior of Captive Small Cetaceans. I: The Bottlenosed Porpoise, *Tursiops truncatus. Sleep Research,* Vol. 3. 1974.

**Flanigan, W. F., Jr.** Nocturnal Behavior of Captive Small Cetaceans. II: The Beluga Whale, *Delphinapterus leucas. Sleep Research,* Vol. 3. 1974.

**Huang, J. C.** Harmonic Frequency Generation by a Pulsating Resonator Sonically Excited. Institute of Electrical and Electronic Engineers, *Transactions on Sonics and Ultrasonics,* Vol. SU-21. April 1974.

**Hunt, J. T., M. R. Knittel, D. Barach.** Finite Element Approach to Acoustic Radiation from Elastic Structures. *Journal of the Acoustical Society of America.* Vol. 55. February 1974.

**Naval Undersea Center.** Technical Publication 352. *Experimental Study of Stochastic Ray Theory Relations,* by J. A. Neubert and D. E. Edgars. August 1973.

**Naval Undersea Center.** Technical Publication 355. *Flanged Acrylic Plastic Hemispherical Shells for Undersea Systems,* by J. Stachiw. September 1973.

**Naval Undersea Center.** Technical Publication 359. *Pull Down Retriever Unit,* by E. N. Rosenberg and S. F. Moran. July 1973.

**Naval Undersea Center.** Technical Publication 371. *Underwater Multiple Scattering of Light for System Designers. Part I: An Exponential Multiple-Scattering Model. Part II: Evaluation of the Exponential Multiple-Scattering Model,* by A. Gordon and M. Knittel. August 1973.

**Naval Undersea Center.** Technical Publication 378. *Recommended Practices for the Design, Fabrication, Prooftesting, and Inspection of Windows in Man-Rated Hyperbaric Chambers,* by J. Stachiw. December 1973.

**Naval Undersea Center.** Technical Publication 383. *Cast Acrylic Dome for Undersea Applications,* by J. Stachiw. January 1974.

**Naval Undersea Center.** Technical Publication 393. *Glass or Ceramic Spherical-Shell Window Assembly for 20,000-PSI Operational Pressure,* by J. Stachiw. May 1974.

**Naval Undersea Center.** Technical Publication 410. *Development of Precision Casting Process for Acrylic Plastic Spherical Shell Windows Applicable to High Pressure Service,* by J. Stachiw. June 1974.

**Naval Undersea Center.** Technical Publication 413. *Limiting Statistics of Fixed-Point Multiplication Errors in Digital Filters with Coefficients of Arbitrary Word Length,* by L. Mulcahy. May 1974.

**Naval Undersea Center.** Technical Publication 414. *Fiber Optic Towed Array,* by J. Redfern, R. Eastley, and D. J. Albares. June 1974.

**Pickwell, G. V., J. A. Vick, W. A. Shipman, M. M. Grenan.** Production, Toxicity, and Preliminary Pharmacology of Venom from the Sea Snake (*Pelamis platurus*). *Food-Drug from the Sea. Proceedings 1972.* Marine Technology Society. Edited by Leonard R. Worthen. 1973.

**Seeley, R., J. L. Mattson.** Simple Clinical Temperature Telemetry System for Pinnipeds. *Journal of Wildlife Diseases,* Vol. 10. July 1974.

**Shipman, W. H., G. V. Pickwell.** Venom of the Yellow-Bellied Sea Snake (*Pelamis platurus*): Some Physical and Chemical Properties. *Toxicon.* Vol. 11. 1973.

**Stachiw, J.** Des Materiaux de Construction Transparents Pour La Recherche et L'Exploration Sous-Marine. *Industries Atomiques et Spatiales.* Vol. XVIII. 1974.

**Stachiw, J.** Failure Modes of Spherical Acrylic Shells Under External Hydraulic Loading. *Hydromechanically Loaded Shells.* The University Press of Hawaii. Edited by R. Szilard. 1973.

**Tiemann, J. J., R. D. Baertsch, W. E. Engler.** Surface-Charge Correlator. *Digests of Technical Papers.* Institute of Electrical and Electronic Engineers. Solid-State Circuit Conference. February 1974.

**Tiemann, J. J., R. D. Baertsch, W. E. Engler.** Surface-Charge Correlator for Signal Processing. *Proceedings of Applications Conference on CCD.* September 1973.

# Presentations

**Barakos, P. A., K. W. Nelson.** Small-Scale Structure of Temperature, Salinity, and Sound Speed off Southern California. *Institute of Electrical and Electronic Engineers, International Conference on Ocean Engineering, Seattle, Washington, 25-28 September 1973.*

**Barakos, P. A., S. L. Speidel.** A Digital Filter for Estimating Small-Scale Structure of Salinity, Temperature, and Sound Speed. *Fall Annual Meeting of the American Geophysical Union, San Francisco, California, 10-14 December 1973.*

**Barakos, P. A., S. L. Speidel.** Amplitude and Phase Fluctuations in Shallow Water. *86th Meeting of the Acoustical Society of America, Los Angeles, California, 30 October-2 November 1973.*

**Barakos, P. A., S. L. Speidel.** Sound Fluctuations and Inhomogeneities in Shallow Water. *87th Meeting of the Acoustical Society of America, New York City, New York, April 1974.*

**Barakos, P. A., S. L. Speidel.** Vertical Microstructure off Southern California. *55th Meeting of the American Geophysical Union, Washington, D.C., 23 April 1974.*

**Batzler, W. E., R. J. Vent.** Acoustic Volume Scattering Project Rarotonga. *87th Meeting of the Acoustical Society of America, New York City, New York, 23-26 April 1974.*

**Fish, J.** Acoustic Research on the Tuna-Porpoise Program. *National Marine Fisheries Service Center, July 1973 to July 1974.*

**Friedl, W. A., W. E. Batzler, J. W. Reese.** The Sampling Ability of Nets: An Assessment Based on Comparisons with Acoustic Volume Scattering Measurements. *37th Annual Meeting of the American Society of Limnology and Oceanography, Seattle, Washington, 24-28 June 1974.*

**Fugitt, R. B.** Small Remotely Manned Undersea Vehicles. *Institute of Electrical and Electronic Engineers, International Conference on Ocean Engineering, Seattle, Washington, 25-28 September 1973.*

**Fugitt, R. B.** Small Remotely Manned Undersea Vehicles. *International Conference with Exhibition for Marine Research and Marine Exploitation, Dusseldorf, Germany, 12-18 November 1973.*

**Gordon, A.** Effective Attenuation Coefficient for Underwater Multiple Scattering of Light. *Optical Society of America, Rochester, New York, 12 October 1973.*

**Heckman, P. J.** Real Time Underwater Optical Mapping Systems. *Defense Mapping Agency Briefing, Naval Observatory, Washington, D.C., 6 March 1974.*

**Stachiw, J., H. Redfoot, K. O. Gray, J. J. Lones, W. Yamaguchi.** Recommended Practices for the Design, Fabrication, and Prooftesting of Acrylic Plastic Windows in Man-Rated Hyperbaric Chambers. *American Society of Mechanical Engineers, Winter Annual Conference 1973, Detroit, Michigan, 11-16 November 1973.*

**Volberg, H. W.** Target Classification and Color Display Techniques. *Underwater Sound Advisory Group, Symposium on High Resolution Sonars, Panama City, Florida, 30 April-2 May 1974.*

**Volberg, H. W.** The Advance Deep Ocean Mapping Sonar (ADOMS). *Defense Mapping Agency Briefing, Naval Observatory, Washington, D.C., 6 March 1974.*

**Weiss, H. V.** Mercury in the Environs of the North Slope of Alaska. *Beaufort-Sea Symposium, San Francisco, California, January 1974.*

**Young, J.** Convolutionally Scanned Multidimensional Arrays. *Underwater Sound Advisory Group, Symposium on High Resolution Sonars, Panama City, Florida, 30 April-2 May 1974.*

# Patents

**Fugitt, Ronald B., Richard W. Uhrich, Jimmy L. Held.** *Remote Control Underwater Observation Vehicle.* Navy Case 54,413.

**Abstract:** A tethered submarine observation vehicle uses a remote, hydraulic-pressure power source. The source is coupled to the vehicle by the same tether which contains the electrical signal transmission facilities.

**Benefit to the Navy:** The remotely controlled vehicle permits observation of underwater phenomena in waters which are unsuited for divers or in circumstances where it would be dangerous to use divers.

**Horn, George M.** *Right Spherical Segment Glass Shell To Metal Joint.* Navy Case 53,027.

**Abstract:** A hemispherical glass dome, ground and lapped with an edge radius of twice the dome thickness, is fitted on a congruently configured mating ring. A bimetallic gasket provides a strain-relieving seal to establish a panoramic viewing port.

**Benefit to the Navy:** The dome provides a wide angle-of-view for submersibles, and the high structural integrity allows safer and more economical construction.

**Igarashi, Yoshiya, James R. Campbell, Richard L. Allman.** *In-Situ Acoustic Sediment Probe.* Navy Case 52,879.

**Abstract:** An acoustic probe for ensonifying bottom sediment includes a concentric pipe arrangement to facilitate central removal of excess sediment. This permits undisturbed and uniform marginal sediment contact with an acoustic transducer mounted on the outermost pipe surface.

**Benefit to the Navy:** This invention provides accurate attenuation data because there is substantially no disturbance of the ocean bottom. As a result, it will be possible to extend the range of torpedoes.

**Johnson, Clarence S., Henry D. Baldridge.** *Electric Antishark Dart.* Navy Case 49,427.

**Abstract:** An electric antishark dart, deployed from a spear gun, immediately incapacitates a threatening shark.

**Benefit to the Navy:** Sharks can be immediately neutralized, allowing divers to work in a safe environment.

**Karig, Horace E.** *Lox Heat Sink System for Underwater Thermal Propulsion System.* Navy Case 54,009.

**Abstract:** This invention provides a low pressure system that supplies small nonnuclear undersea vehicles with a high level of energy. It uses hydrocarbon fuel and oxygen burned in a turbine. The gases pass to a regenerator and then to a condenser for removal of water vapor and carbon dioxide. They are then recompressed and fed back to the combustion chamber. The exhaust products are stored, and there are no excessively high temperatures during heat exchanges.

**Benefit to the Navy:** Using this power system, a submersible has extended range and increased capabilities.

**McLean, William B., Sidney A. Christie.** *Projector of Acoustic Energy.* Navy Case 53,766.

**Abstract:** A freely flooded projector of acoustic energy drives ambient water through a water flow interrupter. An interposed venturi coupled to projector surfaces ensures a more efficient acoustic energy transfer.

**Benefit to the Navy:** Because sealing this transducer poses no problems, high levels of acoustic energy can be projected at any depth.

**Ma, Lawrence.** *Sonar Transducers and Hydrophone Sensitivity Using Dow Corning 111 Compound.* Navy Case 52,179.

**Abstract:** DC-11 compound functions as the coupling for SQS-4 type transducers, that is, a transducer with a closely coupled rubber boot covering the driving or driven element.

**Benefit to the Navy:** This invention provides a compound useful as a high-energy coupling for transducers. It thus improves a hydrophone's performance, including its sensitivity.

**Martini, Leonard J.** *Cooling Water Valve.* Navy Case 54,114.

**Abstract:** This invention is a valve assembly used to open water passages within a torpedo or a similar device to ambient ocean water at a predetermined time.

**Benefit to the Navy:** This invention provides a quick-acting valve which first seals and then safely opens the water inlet port of the Mark 46 torpedo.

**Roberts, Paul G.** *Propeller Type Velocity Indicator.* Navy Case 53,067.

**Abstract:** A fluid velocity indicator uses a propeller driven by fluid flow to rotate a light source. A light sensor detects visual signals from the light to provide an indication of flow velocity and direction.

**Benefit to the Navy:** This invention provides a propeller-type velocity indicator which has good response even at high revolutions-per-minute and is impervious to grease or dirt.

**Rosenberg, Edgar N.** *Spherical Module Connectors.* Navy Case 54,734.

**Abstract:** Alignment and coupling of adjacent bottle-shaped flotation modules into stable, ocean platforms are facilitated by a female portion carried on one module and a spherically shaped male portion carried on an adjacent portion. Upon bringing the two together, water is pumped from a chamber in the female portion to hold them

together. An interposed annular seal ensures a water-tight connection.

**Benefit to the Navy:** This invention facilitates the construction of offshore platforms.

**Seiple, Ronald L.** *Ecologically Controlled Ship's Hull Reconditioner.* Navy Case 52,192.

**Abstract:** A hull cleaner includes articulated rotary brushes laterally displaced by hydraulic rams toward the sides of a ship to scrub away fouling as the ship moves past the brushes. By mounting the hull cleaner on a barge moored outside a harbor and including vacuum lines, fouling is collected and harbor pollution eliminated.

**Benefit to the Navy:** This invention increases the speed and range of Navy ships and prevents harbor pollution.

**White, Elmer.** *Self Descending and Surfacing Water Device.* Navy Case 54,771.

**Abstract:** This invention is an adjustable depth, self-surfacing device for deploying instrumentation, such as a bathythermograph, in the ocean. After the device is dropped from a surface vessel it gathers data as it descends to a predetermined depth. It then ascends to the ocean surface for retrieval. A simple adjustment sets the desired depth, and a free-floating piston increases the capacity of buoyancy of the device upon actuation.

**Benefit to the Navy:** This invention provides an adjustable-depth unit which may be attached to a measuring gauge of various types. The gauge can then float to the surface after the measurements have been taken.